Issues and opinions

Assessment of science and technologies: Advising for and with responsibility

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ABSTRACT

Responsible governance of science and technologies, in particular through the concept of Responsible Research and Innovation (RRI), is becoming increasingly important among policy makers and researchers alike. In this Issues and Opinions Essay we show that influential contributions to this field highlight the need to rethink the relationship between science and society, including rethinking the roles and responsibilities of the different actors in the innovation systems. In this Essay we will focus on the function and practices of *assessment* of science and technologies. With the Essay we would like to open a discussion with academics, assessment practitioners, policy makers and stakeholders about the potential need for reform of current assessment practices and advisory institutions in light of discussions about responsible governance of science and technology in general and RRI in particular.

1. The European policy context for responsibility in science and innovation

Europe is still struggling to recover from the economic crisis and European Union (EU) policies consider science, technology and innovation as key to securing smart, sustainable and inclusive growth. European policy initiatives have been developed that aim to modernize the EU industrial base through accelerating the uptake of innovation. It is assumed that industrial modernization in Europe requires the successful commercialization of product and service innovations, the industrial exploitation of innovative manufacturing technologies and processes, and innovative business models [1].

At the same time Europe has experienced significant public controversy regarding certain novel technology developments. Perhaps the most prominent example was related to genetically modified (GM) foods, leading to a de facto moratorium on GM foods between 1998 and 2005 [2] and there has been a fear that there will be similar public hesitance to other emerging technologies, such a nanotechnologies. Taking this seriously has led the European Commission (EC) to address the relationships between science, technology and society in 'Science, society and the citizen in Europe' [3]. Here it is claimed that 'advances in knowledge and technology are greeted with growing scepticism, even to the point of hostility, and the quest for knowledge no longer generates the unquestioning enthusiasm that it did some decades ago' [4]. Moreover, '[s]earching questions are being asked of the social and ethical

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impact of the forward march of knowledge and technology and the conditions under which the basic choices are made (or are not made) in this area' [4]. Accordingly, the EU has progressively highlighted the need for a socially and ethically responsible governance approach to science and technology, which has been gradually institutionalized in its science, technology and innovation policy. Such an approach acknowledges that the need to ensure a continued focus on Europe as a global leader in innovation must be accompanied by ongoing attention to secure public support for such efforts.

Additionally, the broad recognition that the translation of research into societal benefits cannot be exclusively based on the market and scientific community's self-regulation [5,6] has triggered an increased political will to mobilize and steer innovation for societal goals. Whereas previously science and society had been seen as separate entities (where society was a benign recipient of results from science), there was a development towards conceptualizing science as embedded in a potentially challenging societal context that placed new demands on the societal legitimacy of research and innovation. This has developed further until the current situation where science and innovation may be seen not only as at the service of society, but in fact co-produced with society. This implies that scientific and innovation ventures, and their capacity to answer the challenges facing our society, rest on the joint efforts of scientists, innovators and a broad range of stakeholders, in a responsive relationship with society at large (see e.g. Kuhlmann and Rip, 2014 [7]).

This is expressed in the current ambitious cross-cutting theme of Responsible Research and Innovation (RRI) in Horizon 2020, the most important EU programme for research and development. As a cross-cutting issue it has an impact on all pillars and work programmes. The European Commission (EC) has operationalized RRI in Horizon 2020 as consisting of the following main elements: engage society more broadly in research and innovation activities, increase access to scientific results, ensure gender equality in both the research process and the research content, take into account the ethical dimension, and promote formal and informal science education [8].[1] The inclusion of RRI in Horizon 2020 followed a broader academic and policy discussion on its features and implications. For instance, the EC appointed an independent expert group on RRI [9]. This group described RRI in the following terms:

Responsible Research and Innovation (RRI) refers to the comprehensive approach of proceeding in research and innovation in ways that allow all stakeholders that are involved in the processes of research and innovation at an early stage (A) to obtain relevant knowledge on the consequences of the outcomes of their actions and on the range of options open to them and (B) to effectively evaluate both outcomes and options in terms of societal needs and moral values and (C) to use these considerations (under A and B) as functional requirements for design and development of new research, products and services. The RRI approach has to be a key part of the research and innovation process and should be established as a collective, inclusive and system-wide approach (page 3).

Several other definitions also exist (see for instance Owen et al., 2014 [10] and von Schomberg 2012 [11]). However, most approaches to RRI include the following elements [12]:

In order to be responsible, research and innovation needs to

1. address significant societal needs and challenges
2. engage a range of stakeholders for the purposes of mutual learning
3. anticipate potential problems, identify available alternatives, and reflect on underlying values, and
4. respond, act and adapt according to 1–3

It is important to observe that RRI is not only an answer to the policy and regulatory dilemmas arising from techno-scientific fields whose impacts are poorly characterized or highly uncertain. Instead, RRI seeks to incorporate considerations and knowledge about ethical acceptability and societal needs to steer innovation towards societal goals, trying to answer the question 'what sort of future do we collectively want innovation to create for Europe?' (Owen et al., 2014 [13], 3). As such it highlights the need for society to be involved in governing the purposes of scientific research and technology-infused innovation, acknowledging the centrality of values, interests and purposes in governance, and shifting the discussion from the control of adverse impacts to the orientation of research and technology development activities in order to achieve the 'right impacts' of and through innovation (von Schomberg, 2012 [10], 39). It is from this perspective that RRI has the ambition to integrate previous approaches to the governance of science and technology and research areas that are its direct antecedents, like technology assessment, ethics of technology, ELSA studies, anticipatory governance and public engagement in science and technology [11].

The European Commission is currently working on several questions and dimensions concerning RRI. These cover how to mainstream RRI in Horizon 2020 and in Europe in general, how to federate the RRI community, and how to promote institutional changes to foster RRI in research institutions. This is usually understood as reaching out to research organizations, universities, funding agencies and industry, engage them in RRI and identify good practices that can be proposed as concrete, feasible actions. However, the insight that science and society are inherently interconnected and co-produced, and the new focus on responsibility in science and innovation policy, has implications not only for research funding and for researchers and innovators. The successful implementation of the RRI principles also requires their effective translations in other institutions significantly affecting the science and innovation system and, if needed, their adaptation and change [14].

In this Issues and Opinions Essay we are specifically interested in how new approaches to responsibility in science and technology affects advisory and assessment bodies in the science and technology domain, such as risk

[1] Increasingly governance is mentioned as a sixth and separate key.

assessments, impact assessments, ethical assessments, foresight, economic assessments and (parliamentary) technology assessments (TA) [15]. These bodies are important for modulating how science and innovation is developed and affects society and will therefore impact on how responsible research and innovation will eventually turn out in practice. Responsibility should therefore be conceptualized in the context of assessment of, and policy advice on, scientific and technological options. In this Essay we will address some key issues of responsibility and assessment and discuss these in light of current assessment practices.

The main points in this Essay were presented and discussed at a workshop on responsible governance of science and technologies, held in March 2014 at the European Parliament in Brussels, Belgium.[2] The event was organized by the Science and Technology Options Assessment (STOA) Panel, the European Parliament's in-house source of independent, balanced analysis of public policy issues related to science and technology. STOA's aim is to inform parliamentary debate and keep the Members of the European Parliament up to date with current and emerging science and technology issues and their policy implications,[3] and is in itself one of the assessment institutions that may need to adapt to new approaches to responsibility. The evidence of current assessment practices referred to below reflects results from the European research project EST-Frame, which has studied a broad range of current assessments of emerging science and technologies.[4] The preliminary findings of EST-Frame were presented and discussed during the STOA event.

It should be noted that even though the policy context described here is European the issues we want to raise for discussion have no geographical limit. Indeed, in the above mentioned STOA workshop Indian and Chinese perspectives on responsibility in science and technology were included. Moreover, the most currently influential network on RRI is the Virtual Institute of Responsible Innovation (VIRI) led by the Center for Nanotechnology in Society at Arizona State University. Even if the notion of responsibility may have different cultural interpretations in different regions of the world, experience from dialogues in such fora shows that the discussion on research and innovation is global in nature. Correspondingly, discussions of responsibility in assessment of science and technologies will have a global scope.

2. Responsibility in assessment of science and technologies

We will discuss two different yet connected perspectives on the relation between responsibility and assessment; assessments as enablers for responsible research and innovation and assessment practices as a target for such new responsibility expectations. In both perspectives we will discuss how current assessment practices seem to perform on the responsibility dimensions outlined above (in italics on page 2). But first we will explore the notion of responsibility and its application to institutions (such as advisory institutions) in slightly more detail.

2.1. The notion of responsibility and its application to institutions

As is apparent from the above presentation of RRI approaches this notion can be formulated in various ways. Indeed, the understanding of RRI should have an openness that allows it to be interpreted and adapted to different contexts. In making such adaptations it might be useful to consider the concept of responsibility in some more depth. Pellizzoni [16] has provided an analysis of the concept in the context of policies for environmental protection that is useful also in the context of emerging science and technologies. Pellizzoni outlines two retrospective responsibility dimensions (liability and accountability) and two anticipatory dimensions (care and responsiveness), arguing that the radical uncertainties we are facing today render liability and accountability as weak instruments for ensuring environmental protection. Moreover, he claims that the belief in a state that truly cares for the environment started to shatter in the 1950s−1960s, leaving responsiveness as the most potent responsibility strategy for environmental protection in the light of uncertainty.

This corresponds well with the notion of institutional responsibility developed by the influential American pragmatist Henry Richardson [17]. Richardson argues that responsibility always involves judgments on how general moral rules shall be applied in the specifics of a concrete situation. These judgments are made within an already existing institutional context, but will also contribute to developing this institution, specifying its responsibilities for new situations that will constantly arise. This suggests that responsiveness is always related to a wider institutional context. Furthermore, Richardson's 'publicity principle' of morality requires any moral agent to be able to engage in public dialogue about the justifiability of his or her judgments. This publicity principle is similar to Pellizzoni's dimension of responsiveness in that responsibility requires responding to concerns or arguments in the broader societal context.

With regard to the responsiveness of science as an institution Wynne [18] shows that science has a bad track record of responsiveness and reflexivity. However, as we have seen from the introductory section in this article there seems to have been a change towards more reflexivity in science (at least in European science policy) since Wynne wrote his article in 1993. Wynne offers in this article a useful definition of reflexivity: 'the process of identifying, and critically examining (and thus rendering open to change), the basic, preanalytic assumptions that frame knowledge-commitments' (p. 324). This corresponds well with Pellizzoni' account of responsiveness as *response*, versus *reaction* (p. 557).

[2] http://www.europarl.europa.eu/stoa/cms/home/events/workshops/responsible [accessed 01.06.2014].

[3] http://www.europarl.europa.eu/stoa/cms/home/about [accessed 01.06.2014].

[4] The EST-Frame project is funded by the European Commission's 7th framework, Science-in-Society, programme and coordinated by the main author of this paper.

Perhaps all the four responsibility dimensions in italics on page 2 can be deduced from the notion of responsiveness (and perhaps they could equally be deduced from the notion of care). This is a matter for philosophical discussion that should take place in other fora than this Issues and Opinions Essay. For our purposes here it suffices to conclude with the suggestion that though several accounts of responsibility exist,[5] responsiveness appears to be a central dimension in the context of emerging science and technologies and responsiveness involves a willingness to being challenged by others on assumptions that relate to both facts and values. This responsiveness of the responsible agent will need to be embedded in the institutional context of the agent. In our case, this context is that of assessment institutions. To this we will now turn.

2.2. Assessment for responsibility

The first perspective on the relation between responsibility and assessment refers to the support that the assessment apparatus can provide for responsible development and governance of science and technologies, whether this is framed in terms of RRI or not. This support can be offered by providing extensive peer review of the scientific status in a field necessary for developing appropriate risk assessment and management guidelines; assessing impacts of specific science and technology policies; modeling and integrating available data on economic indicators, trends, etc.; and providing information on other relevant issues, such as ethical concerns or public opinions. At a European level such work is being carried out by institutions like the European Food Safety Authority or the European Group on Ethics in Science and New Technologies. Such advice can assist in specific technology cases (such as specific biotechnology applications) and in the development of a technology field (such as synthetic biology). Moreover, advisory domains bodies can engage citizens, stakeholders, technology developers, and policy-makers in learning processes that are not primarily intended to inform policy-makers, but are in themselves direct governance activities.[6] By providing these functions, assessment and advisory institutions may perform an essential role for responsible technology development and innovation.

Related to the RRI dimensions outlined in italics above, the EST-Frame research [15] suggests that some assessments (often ethical assessments, parliamentary technology assessments and foresight reports) discuss technologies in light of societal needs and challenges, and as such contribute to enabling RRI on this dimension. It is also shown that some assessments (often foresights and impact assessments) engage stakeholders (and sometimes the public) in technology discussions, but these are a minority [15]. Finally, there is evidence that many assessments anticipate potential problems with technologies, but few systematically discuss available alternatives to the technology, and few reflect on the underlying values of such technology development. Moreover, few provide recommendations on how science and technologies can respond to the challenges that correspond with increased focus on societal needs, increased sensitivity for stakeholder concerns or increased reflexivity on one's own choices.

It thus appears that the current institutionalized assessment system as a whole does not yet provide all the resources necessary for responsible science and technology development, if this is understood in RRI terms. Achieving this might require the implementation of limited but significant changes in the current assessment bodies and their functioning (see below). Assessment practitioners, academics, policy makers and stakeholders should consider the need to take action in order to ensure that all RRI dimensions are covered when building an evidence base for policy.

2.3. Assessing with responsibility

The second way advisory practices on science and technologies may respond to RRI is by adopting the RRI principles. In other words, assessment institutions may themselves have a responsibility to address societal challenges, engage with stakeholders and other societal actors, be reflective on their own assumptions and values, and be willing to change as they learn from this. The EST-Frame research indicates that, although there is a certain variation across assessment communities and institutions (for instance the British Nuffield Council on Bioethics comes out as providing gold standard work in the field of ethics), all RRI dimensions are challenging for the advisory domains. We will here discuss in more detail how advisory practices currently appear to respond to the basic RRI dimensions and the potential for institutional adaptations in line with such basic RRI insights.

In a weak sense, all domains currently address significant societal needs as all have a societal function, whether it be that tax payers' money is used in the most effective way, that human rights are not infringed or that risks to the environment from new technologies are at an acceptable level. If a stronger orientation towards societal challenges is desired, more challenge-based institutions could be established, such as the Intergovernmental Panel on Climate Change (the leading international body for the assessment of climate change, established by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO)) [20], bringing together a broad range of disciplinary and interdisciplinary experts for a defined topical area. However, the more disciplinarily defined advisory domains do not need to be considered obsolete; rather, minor institutional reforms (such as increased cross-domain cooperation) could be implemented to ensure better integration and coordination between established domains to join forces to address societal challenges.

Engaging with a wider range of stakeholders would for assessment institutions imply discussing with a diverse set of interested parties how assessments should be carried

[5] See Stilgoe et al., 2013 for an excellent overview of the responsibility concept in RRI [14].

[6] What Kuhlmann and Rip (2014) call 'tentative governance' [19].

out. The findings from EST-Frame indicate that advisory domains are generally expert-based and appear to develop their assessment practices primarily in dialogues with their peers in their home institutions and in dedicated societies or journals. However, the extent to which the domains co-produce their assessment practices with stakeholders and the public should be subject to further research and the desirability of such co-production should be subject to further discussion.

It is more difficult to identify the extent to which the established advisory domains routinely anticipate potential problems with their assumptions, identify available alternatives to the methods they apply, and reflect on the values that underlie the methods and substance of the assessments they produce. This does not mean that such reflection does not exist, but that it is usually not explicitly expressed in their advice or reports. More transparency on such assumptions therefore seems to be called for.

Finally, with regard to responsiveness, we can observe that all the domains engage in methodological development as a response to shifting environmental expectations (cf. Scott's institutionalist account of organisations as open systems [21]), but not necessarily because of RRI-related dynamics such as broad deliberation processes.[7]

3. A research and policy agenda

In the previous section we argued that current assessment practices and advisory institutions are not fully aligned with the basic dimensions of RRI. However, it is not clear if we should expect the same interpretation of responsibility in the context of assessment as in that of the actual development of research and innovation. What is 'responsible assessment' in relation to 'responsible research and innovation'? This question needs further discussion among assessment professionals, academics, policy makers and stakeholders.

There are some arguments against expecting the assessment and advisory system to incorporate all the principles of RRI. One might for instance argue that it should be possible to do a simple survey of consumer attitudes without necessarily relating it to societal challenges. Moreover, some assessments may involve trade secrets, effectively hindering broader dialogue, and in some cases wider stakeholder dialogue may even raise concerns about cartel formation. When it comes to responsibility in risk assessment, this may in fact imply *not* involving stakeholders, so that the perceived objectivity and neutrality of, for instance, a risk assessment is not threatened. In this sense, it might be the risk manager, not the risk assessor, who needs to demonstrate responsibility along the lines of RRI. Such responsibility may include increased reflexive engagement with a wide range of stakeholders and societal actors with regard to decisions about the goals, endpoints and methodologies for the risk assessment, even if the assessment itself remains within the traditional expert-based boundaries.[8]

Arguments of this kind are important to appropriately position the RRI dimensions in relation to assessment practices. Just as important as the appropriate application of responsibility dimensions to assessment practices is the question of how politicians, policy makers and other decision makers commission and receive advice in a responsible way. This easily translates into questions of transparency, a dimension which currently appears to be underdeveloped in RRI.[9] As the Heads of National Food Agencies Working Group on Transparent Use of Risk Assessment in Decision-Making [24] stated: 'the principal challenge is for risk management to develop and promote transparency and rigor in the decision-making process comparable to that in the risk assessment process, so that the basis for risk management and the information and analysis used in this is clear'. Such transparency and responsibility issues apply equally for all use of assessment and advice, not only for risk assessment.

Although there may be limits to what kind of adaptation to the RRI dimensions the different assessment institutions may make, there seems in all cases a potential for better articulating what responsibility might mean, and perhaps particularly in terms of the basic responsibility dimension of responsiveness as laid out in section 2.1. There seems to be room for increased interaction across the institutions and with policy-makers, other stakeholders and societal actors. We would therefore like to re-open the discussion about the need for minor institutional reform, in the sense of creating topic-specific learning spaces where assessment institutions meet to discuss assumptions, framings and method choices in assessment, with relevant policy makers, representatives from industry, and other societal actors. Such broad assessment dialogues will be conducive for the RRI agenda. Through such processes of opening up [25], discussion of societal values and needs for anticipation will have a space, reflexivity will increase and objections and controversies that assessments may incur may be anticipated.

This is not a new idea. Already in 1972 Laurence H. Tribe [26] argued for 'a subtler, more holistic, and more complex style of problem-solving, undoubtedly involving several iterations between problem-formulation and problem-solution and relying at each stage on the careful articulation of a wide range of interrelated values and constraints through the development of several distinct "perspectives" on a given problem, each couched in an idiom true to its internal structure rather than translated into some "common denominator."' (p. 107). More recent scholars,

[7] This point was made about science by Wynne in 1993 and still seems to hold for many assessment institutions today [18].

[8] Good examples of reflexive risk assessment and risk management are provided by the International Risk Governance Council (IRGC) and the Dutch National Institute of Public Health and the Environment (RIVM). An early example of participatory environmental risk management and governance is the UK Royal Commission on Environmental Pollution's report on environmental standards and public values [22].

[9] Richard Owen [23] points out that in retrospect there would have been a case for including openness and transparency in addition to the other responsibility dimensions in the responsible innovation framework of the UK Engineering and Physical Sciences Research Council (EPSRC).

especially in the science and technology studies (STS) tradition, have developed similar lines of thought [25,27,28]. Moreover, in the impact and sustainability assessment traditions, interdisciplinary approaches have been developed, and some argue that TA has always had the ambition of bringing a wide range of advisors together in order to discuss problem definition and assessment methods (see for instance Decker and Ladikas 2004 [29]). However, there is no evidence that these kinds of broader, reflective assessment dialogues have been broadly implemented yet, so this appears still to be a need. The current broad focus on RRI, informed also by the contributions by the scholars and practitioners mentioned above, is likely to yield a more favorable context for succeeding this time.

It is not clear exactly what kind of institutional reform is needed. One option is that existing advisory bodies, such as ethics committees, organize such broader dialogues for their own assessment projects. Another is that existing institutions with a broad mandate, public or private (such as the Dutch NanoNext.nl or the British Synthetic Biology Leadership Council), create platforms for such broad dialogues where advisors from all disciplines can meet. Finally, new ad-hoc cross-domain groups, which have less established institutional path dependencies and cultural biases, might turn out to be more flexible in their approaches. The need for, and potentially the organization of, such dialogues should be a topic for discussion with not only assessment practitioners and academics, but also politicians, civil servants, societal actors and industry. Most likely are there no fixed answers to such questions; rather, experiments in organizing broader assessment dialogues should be carried out in different technology contexts with different assessment goals. Under the auspices of the EST-Frame project, four such assessment dialogues have been organized, in the fields of nano food, biofuels, synthetic biology and cloud computing, with participants expressing satisfaction about the possibility of engaging in broadly scoped problem definition and method choice discussions.

4. Conclusion

With this Issues and Opinions Essay we intend to open up a discussion about the relationship between current approaches to responsibility and practices for assessing science and technologies. In the Essay we have discussed the application of basic RRI-related principles to practices and institutions for assessment of emerging science and technologies. We have raised questions about the need for minor institutional reform of current advisory practices and institutions in light of discussions about responsible and responsive governance of science and technology in general and RRI in particular. We have suggested that broad assessment dialogues will be conducive for the RRI agenda and though the concept and intention of such broad assessment reflection is not new, the research shows that there still is a need to operationalize and institutionalize it. We welcome a broader discussion on the principled and practical dimensions related to advising for and with responsibility. In this respect, at least three questions seem to be important:

- What does it mean for assessment institutions to be responsive to societal actors?
- Is there a need for a 'soft institutional reform' of assessment institutions to align these with current approaches to responsibility in science and technology?
- How should assessments of emerging science and technologies contribute to RRI?

However, even if these questions seem to be essential, we welcome all perspectives on the issues raised in this Essay.

Disclaimer

The views expressed in this publication are the sole responsibility of the authors and do not necessarily reflect the views of the affiliated organizations.

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